Journal of Scientific Research and Reports

Volume 30, Issue 11, Page 742-748, 2024; Article no.JSRR.125570
ISSN: 2320-0227

Analysis of the Impact of Low Tunnel Technology on Farm Income of Bottle Gourd Growers in the Bikaner District of Rajasthan, India

Priyanka Yadav [a*], Vikram Yogi [b++], Vijender Kumar [a], Lal Chand Yadav [a] and Narendra Yadav [a]

[a] Department of Agricultural Economics and Management, Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan, 313001, India.
[b] Department of Agricultural Economics, College of Agriculture, SKRAU, Bikaner, Rajasthan, 334006, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.9734/jsrr/2024/v30i112601

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/125570

Original Research Article

Received: 26/08/2024
Accepted: 29/10/2024
Published: 14/11/2024

ABSTRACT

A field survey was conducted on farmers of Bikaner district to analyze of impact of low tunnel technology on farm income of bottle gourd growers with low tunnel technology and open field in Bikaner district. A total of 60 farmers was selected randomly i.e. 30 farmers with low tunnel technology and 30 farmers without low tunnel technology. The primary data was collected from the selected cultivators using the personal interview method. A partial budgeting technique was used

[++] Assistant Professor;
**Corresponding author: E-mail: pinku.kiran.sachin@gmail.com;*

Cite as: *Yadav, Priyanka, Vikram Yogi, Vijender Kumar, Lal Chand Yadav, and Narendra Yadav. 2024. "Analysis of the Impact of Low Tunnel Technology on Farm Income of Bottle Gourd Growers in the Bikaner District of Rajasthan, India". Journal of Scientific Research and Reports 30 (11):742-48. https://doi.org/10.9734/jsrr/2024/v30i112601.*

for the impact of low tunnel technology. Partial Budgeting was used to calculate the economic impact of a single technology adoption. The result showed that the total operational cost in low tunnel technology is ₹ 123783.23 per ha and in open field total operational cost is ₹ 80883.23 per ha. In low tunnel technology 27.66 percent cost incurred in human labour followed by seed cost with 10.94 percent, while in open field it was 25.56 percent and 13.85 percent respectively. The gross return in low tunnel technology was ₹ 350000.00 per ha, in the open field ₹ 160000.00 per ha, the net return in low tunnel technology was ₹ 226216.77 per ha and ₹ 79116.77 per ha in the open field. The benefit-cost ratio of low tunnel bottle gourd production was 2.82 and in the open field, it was 1.97. In low tunnel technology, the added cost is ₹ 26822.26 per ha and the added return is ₹ 190000.00 per ha. In low tunnel technology bottle gourd production average yield is 250 Qt per ha and in open field average yield is 200 Qt per ha.

Keywords: Partial budgeting technique; gross return; benefit-cost ratio; added cost; added return.

1. INTRODUCTION

The area under the hot arid zone in India is 31.7 M.ha (12% of the country's total geographical area) which is mainly spread over Rajasthan, Gujarat, Andhra Pradesh, Punjab, Haryana, Karnataka and Maharashtra. The major part of the hot arid region lies in western Rajasthan (19.62 M.ha) followed by north-western Gujarat (2.16 M.ha). The region is characterized by extremes of temperature, low and erratic rainfall, high evapotranspiration rate, high wind velocity, dust storms, high soil pH, high infiltration rate, limited groundwater availability, and saline ground irrigation water. The studies of various researchers reported that arid region soils are low in organic matter, macronutrients and micronutrients (Jatav *et al.* 2016a & 2016b, Meena *et al.* 2016, Saroj *et al.* 2020, Meghwal *et al.* 2022). Despite adverse climatic conditions the region has good potential to grow cucurbits. However, due to high temperature and hot wind in the summer season, low yield and poor quality of the product are obtained (Choudhary *et al.* 2015).

Under such harsh climatic conditions, open vegetable cultivation yields poor-quality produce and less returns. By creating a suitable micro-climate for plant growth through protected cultivation structures like low tunnels, the cultivation of vegetables can be done around the year even under adverse climatic conditions. Low tunnels are modified miniature structures working on the greenhouse concept. In India. Agriculture facing challenges like dwindling land holdings and noticeable shifts in weather patterns, protected cultivation has emerged as a prime solution for maximizing land and resource utilization. The primary objective of this technology is to bolster the socio-economic status of farmers (Mehta *et al.* 2020).

Production of vegetables under protected structures such as low tunnels provides the best way to increase the productivity and quality of vegetables, especially cucurbits. Low tunnels are also advantageous in warming the soil, protecting the plants from bad weather, preventing the plant from getting injured and rows or individual beds of transplanted vegetables to enhance plant growth by warming the air around the plants in the open field. Vegetables can be cultivated in the off-season, with the introduction of greenhouses, and low and high poly tunnel technology, in which temperature and moisture are controlled for specific growth of vegetables (Lodhi *et. al.,* 2015).

Low tunnels are being used for producing high-quality, high-value nurseries and crops such as tomatoes, cucumber, radish, beans and capsicum with this technology, the farmer's bottle ground can capture the market in the early season and may get a good return of the produce. Another advantage of such technology is that low tunnel scan be easily dismantled and used in the next year. Nowadays season vegetable nursery production under a protected structure has become a profitable business. The main purpose of raising nursery plants in protected structures is to get higher profit and disease-free seedlings in the off-season to raise early crops in protected conditions and open field conditions (Cheema *et al.*, 2004).

The temperature inside the polyhouse is higher than outside during winter. The cold waves during the winter season (December to February) do not enter inside the poly house and the inside environment becomes conducive for the quick germination of seed and growth of seedlings. Many times farmers produce a good amount of cucumber, capsicum and tomatoes during the

Chart 1. Profit/Loss = (Added return - Added cost) + (Reduced cost – Reduced return)

Added cost - These will be the cost incurred, bottle grower under low tunnel	**Added cost -** These will be the cost incurred, bottle grower under low tunnel
Reduced Return - Decrease in the return is observed when bottle gourd grower under low tunnel	**Reduced cost -** Decrease in the costs is found when bottle gourd grower under low tunnel
Net change = Total benefits – Total costs	

main season, which eventually leads to a market glut and a fall in price growth (Yadav *et al.*, 2014).

Indian farmers produce the bulk of vegetables but there is an important question whether they are technically efficient in vegetable production because technical efficiency is the heart of agricultural production. This scope of agricultural production can be expanded and sustained by farmers through efficient use of resources. For this reason, efficiencies have remained an important subject of empirical investigation particularly in developing economies where the majority of the farmers are resource-poor (Gabriel *et. al.,* 2006).

2. MATERIALS AND METHODS

Gross returns: Gross returns were obtained by multiplying the total product with the price realized.

Net returns over operational cost: Net returns were obtained by deducting the total costs incurred from the gross returns obtained.

Benefit-cost ratio over operational cost: Return per rupee of the cost was obtained by dividing the gross returns by the cost of cultivation.

The Partial budgeting technique was used for the impact of low tunnel technology. Partial Budgeting was used to calculate the economic impact of a single technology adoption. This method requires less data and allows early conclusions. In this method, if the profit remains the same or decreases the technology is not more profitable than the technology used by the farmer and therefore it should not be recommended. If the profit increases, the technology should be recommended to the farmers.

3. RESULTS AND DISCUSSION

3.1 Cost of Bottle Gourd Cultivation in Low Tunnel and Open Field Condition

In this section cost of cultivation of bottle gourd was presented in both conditions low tunnel and open field. The impact of technology adoption is

Table 1. Input used in bottle gourd cultivation under low tunnel technology and open field cultivation (₹/ha)

S. No	Particulars	Low tunnel	Open field
1.	Seed	17925.68 (10.94)	16746.02 (13.85)
2.	Machine labour	6344.36 (3.87)	5896.84 (4.87)
3.	Fertilizer	8034.57 (4.90)	7630.27 (6.31)
4.	Irrigation	2763.25 (1.68)	5392.12 (4.46)
5.	Plant protection	3995.22 (2.44)	3349.54 (2.77)
6.	FYM	12579.15 (7.68)	12361.46 (10.22)
7.	Human labour	45318.64 (27.66)	30906.84 (25.56)
8.	Polythene sheet	19815.56 (12.09)	-
9.	Structure frame	7006.80 (4.27)	-
10.	Operational cost	123783.23 (75.57)	80883.23 (66.91)
11.	Overhead cost	40000 (24.43)	40000 (33.09)
	Total cost	**163783.23 (100.00)**	**120883.23(100.00)**

Note: - Value in Parentheses is in percentage

Table 2. Yield, Cost and Return in low tunnel technology and open field bottle gourd production

Particulars	Low tunnel	Open field
Average Yield (Quintal/ha)	250	200
Price(₹/kg)	14	8
Total cost (₹/ha)	123783.23	80883.23
Gross return (₹/ha)	350000.00	160000.00
Net return (₹/ha)	226216.77	79116.77
B: C Ratio	2.82	1.97

Table 3. Cost of inputs used in low tunnel and open field bottle gourd grower (₹/ha)

Particulars	Low tunnel	Open field	t-test	%Change
Seed	17925.68	16746.02	-0.139	7.0
Machine labour	6344.36	5896.84	1.028	7.5
Fertilizer	8034.57	7630.27	-0.81	5.2
Irrigation	2763.25	3392.12	2.24**	- 4.8
Plant Protection	3995.22	3349.54	-4.75*	4.9
FYM	12579.15	12361.46	-0.16	1.7
Human Labour	45318.64	30906.84	-2.38**	27

*Note: * indicates a 1% level of significance and ** indicates a 5% level respectively.*

Table 4. Impact of low tunnel technology on the income of the farmers

Added Cost(₹/ha)			Added Return(₹/ha)
Polythene sheet	=	19815.56	Return=190000.00
Structure frame	=	7006.80	
Reduced Cost			Reduced Return
Nil			Nil
Net profit=Total return–Total cost			
Net profit=190000.00-26822.26=163177.74			

also presented in this section. Table 1 shows that the cost of cultivation with the low tunnel technology was ₹163783.23 and the cost of cultivation in open field was ₹120883.23. The cost of cultivation is high in low tunnel technology due to added costs and maintenance costs. Both methods have similar seed costs, but the low tunnel method incurs slightly higher expenses (₹17,925.68) compared to the open field (₹16,746.02). The low tunnel method requires more machine labor (₹6,344.36), although not significantly higher than the open field (₹5,896.84). While fertilizer costs are comparable, irrigation is significantly cheaper in the low tunnel method (₹2,763.25) than in the open field (₹5,392.12), likely due to better water management under the tunnel system. Plant protection costs are slightly higher in the low tunnel system (₹3,995.22), while FYM costs are almost the same in both methods. The low tunnel method demands significantly more human labor (₹45,318.64) compared to open field (₹30,906.84). This might be due to the additional tasks involved in managing the tunnel structure. The low tunnel method incurs unique expenses such as polythene sheets (₹19,815.56) and structure frame costs (₹7,006.80), which are absent in open field cultivation. The operational cost in the low tunnel method have 75.57 per cent of the total cost, while in open filed it was 66.91 per cent of the total cost. The overheated or fixed cost was same for both conditions but they contribute 24.43 per cent in low tunnel method and 33.09 per cent in open filed method.

3.2 Income Measure from Bottle Gourd, in Low Tunnel and Open field Conditions

The gross return and net return were ₹350000.00 per ha and ₹226216.77 per ha respectively in low tunnel technology while in the open field conditions, gross return and net return were ₹160000 per ha and ₹79116.77 per ha respectively as given the Table 2.

The Table 2 compares the profitability of agricultural production under low tunnel and

open field cultivation methods. In terms of yield, the low tunnel method produces a higher average yield of 250 quintals per hectare, compared to 200 quintals per hectare in open field cultivation. In the similar study conducted by Pramod (2018), *Tulsi* variety of bottle gourd recorded its highest yield of 49.2 t/ha when grown under black plastic mulch with a plastic low tunnel. Conversely, the *Warad* variety of bottle gourd recorded its peak yield of 64.4 t/ha when cultivated under transparent plastic mulch. Additionally, the selling price of crops grown under the low tunnel method is significantly higher at ₹14 per kg, compared to only ₹8 per Kg in open field cultivation.

Despite the higher operational cost for the low tunnel method (₹1,23,783.23 per hectare) compared to the open field (₹80,883.23 per hectare), the gross return from the low tunnel method is substantially greater, reaching ₹3,50,000 per hectare compared to ₹1,60,000 per hectare from open field cultivation. This results in a much higher net return for the low tunnel system (₹2, 26,216.77 per hectare) compared to open field cultivation, which generates a net return of ₹79,116.77 per hectare. The Benefit-Cost (B: C) Ratio also reflects the greater profitability of the low tunnel system, with a ratio of 2.82, meaning for every ₹1 invested, ₹2.82 is returned. In contrast, the open field method has a B:C ratio of 1.97, indicating lower returns on investment. The similar findings were earlier reported by Tahir and Altaf (2013), Choudhary *et al.* (2018) Rajput *et al.* (2020). Overall, while the low tunnel method involves higher costs, it offers significantly better economic returns.

3.3 Significance of Input Used in Bottle Gourd Cultivation in Low Tunnel and Open Field Conditions

Table 3 shows the costs of inputs used in low tunnel and open field bottle gourd growers. Irrigation and human labour were significant at 5 per cent level of probability while plant protection was at a 1 per cent level of significance. The economics of bottle gourd production under low tunnel technology and open field indicated that the human labour cost accounted for the highest share of total operational cost in low tunnel technology, it was 27 per cent higher than in open field conditions. The machine labour cost was 7.5 per cent higher than in the open field conditions. Similarly, the cost of seed was 7.0 per cent higher, the fertilizer was 5.2 per cent higher, plant protection was 4.9 per cent higher, and FYM was 1.7 per cent higher than in the open field conditions, while irrigation cost was 4.8 per cent lower in low tunnel technology as compared to open field conditions because in low tunnel technology, water efficiency was higher and the covering material acts as the plastic mulch to conserve moisture in the soil for longer duration Similar findings were reported by Yogi *et al.* (2016) and Orlando *et al.* (2021) Wei *et al.* (2020). In the study conducted by Mehta *et al.* (2020) on protected cultivation, they reported that labor engagement in protected cultivation was nearly quadruple compared to open-field methods, signifying a substantial boost in employment prospects. With the adoption of protected technology, the average income at both farm and household levels for growers witnessed an approximate increase of 25 per cent and 11 per cent, respectively.

3.4 Impact of Low Tunnel Technology on the Income of the Farmers

The partial budgeting analysis presented in Table 4 shows that the additional cost incurred in low tunnel technology was ₹26822.56 per ha. The major cost was polythene sheet which accounted for ₹19815.56 per ha. The cost of the structure frame was ₹7006.80 per ha. The net profit was ₹163177.74 per ha. The benefit-cost ratio was 2.82. It shows that low tunnel technology positively impacts the farmer's income.

4. CONCLUSION

The low tunnel method incurs higher overall costs due to added expenditures for materials (polythene sheets, structure frame) and more human labor, but it may offer better protection and resource efficiency (lower irrigation costs). On the other hand, open field cultivation is cheaper but might be less controlled in terms of environmental factors. The Benefit-Cost (B: C) Ratio also reflects the greater profitability of the low tunnel system, with a ratio of 2.82. In contrast, the open field method has a B: C ratio of 1.97, indicating lower returns on investment. The partial budgeting technique was used to analyses the impact of low tunnels on the income of the bottle guard growers. The result of partial budgeting shows that the additional cost incurred was ₹ 26822.26 per ha and the net profit was ₹ 163177.74 per ha. The result shows a positive impact on farmer income.

5. LIMITATIONS AND FUTURE STUDIES

5.1 Limitations

Sample Size: This study involved a relatively small sample of 60 farmers from the Bikaner district. However, a larger and more diverse sample could provide more comprehensive insights into the impact of low tunnel technology on bottle gourd growers' income.

Geographical Scope: The findings of this study are specific to the Bikaner district of Rajasthan and may not be applicable to other regions with different agro-climatic conditions. Future research should consider conducting similar studies in various geographic locations to assess the technology's broader effectiveness.

Timeframe: The study's timeframe may limit the understanding of the long-term implications of adopting low tunnel technology. Future research could explore the technology's sustainability and effectiveness over multiple growing seasons and under varying market conditions.

Data Collection Method: While data was collected through personal interviews, potential biases or errors may exist due to self-reported information. Utilizing additional data collection methods, such as field observations or farm records, could improve the reliability of the findings.

Cost Considerations: This study primarily focused on operational costs and returns without considering long-term investments or external factors such as government policies or market fluctuations. Future research should incorporate these factors to provide a more comprehensive analysis of the technology's economic viability.

5.2 Future Studies

Socio-economic Impact: Future research should explore the broader socio-economic implications of adopting low tunnel technology, including its effects on employment, income distribution, and rural development in the Bikaner district.

Technology Optimization: There is a need to explore ways to optimize low tunnel technology to enhance its benefits further. This could involve experimenting with different materials, designs, or management practices to improve crop yield and resource efficiency.

Environmental Sustainability: Investigating the environmental sustainability of low tunnel technology, such as its impact on soil health and water usage, would be essential for assessing its long-term viability and compatibility with sustainable farming practices**.**

Market Dynamics: Future studies could analyze the market dynamics of bottle gourd production under low tunnel technology, including market demand, price fluctuations, and marketing strategies, to help farmers maximize their profitability.

Farmers' Perception and Adoption: Qualitative research methods should be employed to understand farmers' perceptions, attitudes, and adoption barriers towards low tunnel technology. This would provide valuable insights to promote its uptake and implementation.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

I declare that no generative AI technologies such as large language models (Chat-GPT) and text to image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

Cheema, D. S. P., & Kaur, S. (2004). Off season cultivation under net house condition. *Acta Horticulture*, 659, 177-181.

Choudhary, B. R., & Verma, A. K. (2018). *Prospects of protected cultivation in hot arid region* (Technical Bulletin No. 69).

Choudhary, B. R., Sharma, S. K., & Janakiram, T. (2015). Cultivation of cucurbits in arid Rajasthan fetches more. *Indian Horticulture*, 60(3), 22-24.

Gabriel, S. U. (2006). Resources use efficiency in urban farming: An application of stochastic frontier production function. *International Journal of Agricultural Biology*, 8(1), 38-44.

Jatav, M. K., Sharma, B. D., Samadia, D. K., & Meena, S. R. (2016a). Yield of *kachri* (*Cucumis callosus*) as influenced by organic and inorganic sources of nutrients

in arid zone. *Indian Journal of Agricultural Sciences*, 86(7), 961-963.

Jatav, M. K., Sharma, B. D., Samadia, D. K., & Meena, S. R. (2016b). Site specific nutrient management of *kachri* in hot arid region. *International Journal of Basic and Applied Biology*, 3(2), 2349-2539.

Lodhi, A. S., Kaushal, A., Kamal, G., & Singh. (2015). Low tunnel technology for vegetable crops in India. pp. 3-10.

Meghwal, P. R., Singh, A., & Singh, D. (2022). Underutilized fruits and vegetables in hot arid regions of India: Status and prospects: A review. *Agricultural Reviews*, 43(1), 38-45.

Mehta, K., Thakur, R. K., & Guleria, J. S. (2020). Socio-economic impact of protected cultivation on tomato growers of Himachal Pradesh. *Economic Affairs*, 65(1), 1-7.

Nirpal, R. S., Pokharkar, V. G., Yadav, D. B., & Joshi, V. R. (2021). Impact analysis of university released onion varieties on farm economy. *The Pharma Innovation Journal*, 10(7), 401-406.

Orlando, F., Izaba, R., Guan, W., & Ariana, P. T. (2021). Economic analysis of growing grafted cucumber plants for high tunnel production. *HortTechnology*, 31(2), 181-187.

Pramod, R. (2018). Off season bottle gourd cultivation using plastic mulch and low tunnel. *HortFlora Research Spectrum*, 7(1), 19-23.

Rajput, A. S., Sharma, V., & Sharma, R. C. (2020). Costs and returns structure in bottle gourd on the contract vis-a-vis non-contract farms in the Jaipur district of Rajasthan. *Economic Affairs*, 65(4), 665-674.

Saroj, P. L., Ram, C., & Kumar, K. (2020). Arid horticultural crops: Status and opportunities under changing climatic conditions. *Indian Journal of Plant Genetic Resources*, 33(1), 17-31.

Tahir, A., & Altaf, Z. (2013). Determinants of income from vegetables production: A comparative study of normal and off-season vegetables in Abbottabad. *Pakistan Journal of Agriculture Research*, 26(1), 24-31.

Wei, X., Khachatryan, H., & Rihn, A. (2020). Production costs and profitability for selected greenhouse grown annual and perennial crops: Partial enterprise budgeting and sensitivity analysis. *HortScience*, 55(5), 637–646.

Yadav, R. K., Kalia, P., Choudhary, H., & Brihamadev, H. Z. (2014). Low cost polyhouse technologies for higher income and nutritional security. *5(3)*, 191-196.

Yogi, V., Kar, A., & Kumar, P. (2016). Impact of conservation agricultural practices on economics of wheat cultivation in Haryana. *International Journal of Bio-resource and Stress Management*, 7(6), 1387-1391.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/125570